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Seeing the miraculous in the common: Re-mainstreaming the use of sustainable building materials

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Abstract: Europe is in danger of losing much of the knowledge and skills needed to sustain the traditional industries that supply natural and sustainable materials and products to architects, the construction industry and housebuilders. This paper describes the outcomes and knowledge developed as part of the Natural Energy Efficiency and Sustainability (NEES) Project, funded by the European Regional Development Fund's Northern Periphery Programme and delivered by partners across Scotland, Ireland, Northern Ireland, Sweden and Greenland. The project focused on the development of the 'NEES Process' to identify and promote fifteen examples small to medium-sized enterprises demonstrating best practice in the use of natural and recycled building materials sourced from Northern Europe. As well as being exemplars of energy and / or resource efficiency the NEES Best Practices were also selected for being sensitive to local architectural heritages, cultures, and traditional industries. As part of this project a number of key opportunities and barriers for increasing the take up of locally-sourced sustainable materials, products and services were identified; including the potential co-benefits to other sectors, the need to stem the loss of traditional knowledge and skills, and the litigious nature of some larger producers of conventional building products and materials. This paper also describes the knowledge and practice gaps that need to be closed in order to reintroduce and mainstream the use of traditional and sustainable building materials into architectural practices and public procurement policies, and from there to re-mainstream their use by local tradespeople and householders. Finally, it questions the value of the government led agenda for innovation in building materials where natural and traditional materials can offer equal, or near equal, levels of energy efficiency whilst providing additional co-benefits to householders, local communities, the environment, society, and regional economies.

Keywords: sustainable, natural, building, materials, energy efficiency

Introduction

The critical importance of realising sustainability and the central role of the built environment in achieving this is recognised at the highest levels (UN Habitat, 2008; European Commission, 2007; WCED, 1987). However, current sustainability assessment protocols are largely confined to assessing the environmental performance of buildings and fail to address their impact on quality-of-life and the interrelationship between the two thus not optimally aligning with the principles of sustainable development. Even within the current environmental focus, the emphasis is often on a narrow range of issues such as energy performance (for example, The Energy Performance in Buildings Directive – European Commission, 2002) and material use ("Environmental Product Declaration" EPD, 2008). As such, sustainability in its widest sense of delivering quality-of-life while improving environmental performance, is yet to be fully operationalised because existing assessment tools and protocols are insufficient for capturing these 'co-benefits' (Pridmore et al., 2017).

In this paper we present the philosophy behind the criteria development and evaluates the results obtained in selecting and accrediting sixteen examples of Best Practice as part of the European Regional Development Fund's Natural Energy Efficient and Sustainability (NEES) Project (NEES, 2016).

Background

Despite their shortcomings, a plethora of sustainability assessment methods (SAM's) have emerged recently. As early as in 2005 Walton et al (2005) identified that there were over 600 tools dealing with one or more aspects of sustainability in buildings. Despite the abundance of tools, the landscape is incomplete in its coverage of sustainability themes, with no one sustainability assessment tool providing complete coverage and the criteria around which the method is developed, often reflecting variations in their interpretation of the concept. Poston et al. (2010) conducted a comparison of the thirty most commonly used SAM's to explore the coverage of their criteria against a holistic interpretation of sustainability. The findings of the survey confirmed the incomplete coverage of criteria against economic, environmental and social themes and confirmed a tendency to focus on environmental impacts often from a technical standpoint, thus failing to account sufficiently for cultural and economic considerations which are important to the aim of the NEES project.

In establishing the basis for an assessment criteria for selecting best practice products and services based on the principles of the NEES project, there was a need to go beyond what is commonly reflected within the criteria used by common sustainability assessment tools. We therefore considered established criteria within common tools, criteria emerging within tools which reflect novel articulations of sustainability, and drew on sustainable material frameworks such as NaturePlus^{TM} (NaturePlus, 2017) for validation.

Method

Our approach drew on the experience of the SUE-MoT research project (SUE-MoT, 2008) involving Glasgow Caledonian University (GCU) which developed a criteria for assessing sustainability of building projects. This criteria was tailored for the context of sustainable materials and cross mapped with the criteria displayed in novel articulations within SAM's (Poston et al. (2010) and drew on a sustainability materials selection criteria developed by

GCU with a housing development team and housing association. The emerging materials selection criteria was developed around bioregional principles but was established from the same reductionist approach. The criteria embodied many of the environmental principles reflected in NEES, but a need existed to tailor the criteria to reflect the future potential of the product or service within the market and the context of the Northern Peripheral Programme (NPP) regions (geographic, cultural, economic, skills and traditions). The emerging criteria was validated through comparison with the NaturePlus^{TM} criteria (NaturePlus, 2017) which focused on the technical elements of resource efficiency, environment and health criteria; but were found to lack the wider sustainability, enterprise and scalability criteria important to NEES.

Consultation with the NEES partners and stakeholder experts was an important element of the refinement process with a view to ensuring the emerging assessment criteria met with the principles pursued within the project, best practice and to enable regional variations to be reflected (i.e. Scotland, Ireland, Northern Ireland, Sweden and Greenland). This process aided in establishing a firm understanding of the NEES philosophy and its articulation in the context of the criteria. An expert panel was convened comprising of professionals in sustainable design and construction from the different partner regions. They provided technical input, and ensured that the emerging criteria reflected the latest interpretation of best practice to sustainable materials within their regions.

Emerging from this was an aim for NEES to seek to promote products which "were comprised of a minimum of 85% of renewable raw materials, or mineral based materials which are almost unlimited in their availability". The synthetic or high-tech components of such products were strictly limited and reduced to the minimum level that is technically possible. Harmful emissions were avoided and on the other, and the use of fossil fuels and limited natural resources were minimised. The origins of the raw materials were carefully checked. NEES also seeks to promote services if they "were based on the use of such products, and their implementation has no or limited environmental impact".

To ensure that products and services considered for selection as Best Practices meet this philosophy, three 'gateway' criteria were introduced to eliminate quickly failing submissions from the process:

- Use of natural and / or recycled materials
- Suitable for retrofitting to improve the energy performance of buildings
- Sourced from the NPP region, or those with main market in the region.

Those products and services that meet all three of the gateway criteria are then scored against five NEES assessment criteria (Table 1). The first two criteria aligned with the NaturePlus criteria, the findings of the SUE-MoT project and the sustainable building materials criteria developed by GCU. The third expands these to cover a wider definition of sustainability incorporating social, cultural; heritage aspects and wider economic impacts, and the latter two are more blunt assessments of success and future market potential. On passing the three 'gateway' criteria, representatives of the products and services were asked to submit an application for consideration as a promoted best practice through the NEES website. The application was in the form of an online survey designed according to whether the applicant provides a product or service. The product survey set specific

questions designed to draw out pertinent information that may not be obvious to applicants. The initial version of the services survey was simplified following feedback from respondents and the expert panel. The survey then focused on requesting case studies that address the 'natural / recycled', 'energy efficient' and 'sustainable' aims of the project.

Table 1. The NEES Assessment Criteria

Criteria	Aspects of sustainability assessed
Resource efficiency	This captures the more quantifiable impacts of the products and services, including life cycle costs, carbon footprint, and energy savings attributable to use
Environment and health	This captures less directly quantifiable impacts such as pollution and any hazards to human health (from installation and use)
Sustainability	This captures socio-economic impacts as well as cultural issues such as sensitivity to regional architectural traditions
Enterprise	This captures the growth, to date, of the product or service (given that all applicants must be SMEs or smaller)
Scalability	This captures the potential for growth, including the sustainability of the product or service if demand were to grow significantly, as well as the value that could be added by involvement with the project.

In line with the Delphi Process (Dakley & Helmer, 1963) the completed assessments were passed to a panel of independent experts (one representing each partner region) to score and evaluate against a standard marking scheme. The results were collated, the highest and lowest marks removed, and the average of the remainder taken. Those scoring above or below 7 under all five criteria are automatically accepted or rejected and the rest were further evaluated at a meeting of the panel, who had the option of accepting, rejecting, or referring a submission back for (specific) information. The whole process is therefore designed to eliminate professional bias, minimise the time needed from experts, and facilitate more detailed discussion where this is needed regarding the characteristics of the NPP regions. The panels were established partly to overcome the research/ information gap surrounding the performance of products and services aligned with the NEES criteria and to ensure professional opinion and experience within the NPP regions was reflected.

Outcomes and Discussion

Table 2 details the Best Practices and the main reasons for their selection by the panel. In Scotland and Ireland there was observed a high proportion of submissions from small micro-enterprises which displayed limited business skills and resources to grow their product and business. A committed community of architects providing sustainable design services was represented but reported a real challenge finding suppliers within the local area for sustainable materials. Both these regions exist close to large urban areas (central belt of Scotland; Dublin and Belfast in Ireland) which can service this market with products and services resulting in an abundance and dominance of contemporary materials.

In Sweden, the submissions were largely from large companies who have invested in developing products with a view to promoting these on the Swedish and global markets. Due to low population levels the potential for commercial activity servicing a local market is limited and this is reflected in the lack of micro enterprises promoting products and services.

Table 2. The NEES Best Practices

Name	Country	Materials	Reasons for selection
Advanced Timbercraft	Northern Ireland	Timber; cellulose; hemp; sheepswool; woodwool; wood fibre	Family-run firm specialising in low energy, high thermal performance buildings, using recylable and biodegradable materials
Anu Green	Ireland	Structural materials for roofing; soil / bedding material; plants / grasses	60-100% use of recycled materials; co-benefits of green roofs
Ecological Architecture	Scotland	Local, sustainable timber; hempcrete; reclaimed stone; sheepswool; etc	Pioneering and innovative ecological architectural practice established by two (female) experts
Enviroglass	Shetland, Scotland	Processes recycled glass into aggregates and paving materials	Recycles ~99% of Shetland's waste glass, which would otherwise be shipped to the mainland
Ecocel	Ireland	Processes recycled cellulose (newspapers) into blown-fibre insulation	Highly sustainable; non-toxic; suitable for retrofitting into difficult spaces; proven to provide better thermal regulation than conventional insulation
FH Wetland Systems	Ireland	Constructed wetlands; reed beds; zero discharge willow facilities	Natural and sustainable solution to wastewater treatment; reduces infrastructure energy costs
The Hollies Centre for Sustainability	Ireland	Cob; bale cob (strawbale and cob hybrid); timber; stone; clay; sand; lime; locally-sourced earth pigments	Example of a consultancy which also provides training in the use of natural building materials
Inzievar Woodlands	Scotland	Native Scottish hardwood and softwood timber	Mixed woodland managed for co-benefits – recreation, tourism, etc; sawmill is Scotland's main processor of native timber
Locate Architects	Scotland	Local, sustainable timber; hemp insulation; natural paints; Scottish linoleum;	Best practice in combining natural and sustainable materials with modern design approaches – PassivHaus, etc
MAKAR – Design and Build	Scotland	Architectural practice specialising in off-site construction using local, natural and sustainable materials	Use of local, natural and sustainable building materials; dwellings are nearly 100% recyclable or biodegradable; off-site construction using lightweight materials reduces embodied energy costs in rural / island areas
MAKAR - nSIPS	Scotland	Natural structually-insulated panels manufactured from local timber and recycled cellulose	Economically and socially sustainable - contributes to rural regeneration – has grown to ~30 staff and apprentices
Martinsons - Gluelam	Sweden	High strength locally-sourced structural timber product	Use of local timber; economically and socially sustainable in a rural region with a low population density
Martinsons - Xlam	Sweden	High strength locally-sourced structural timber product	Use of local timber; economically and socially sustainable in a rural region with a low population density
Masonite Beams	Sweden	Floor, wall and roof systems using locally-sourced timber	Use of local timber; economically and socially sustainable in a rural region with a low population density
Mud and Wood	Ireland	Cob; lime; reclaimed timber; straw bale	Example of a consultancy which also provides training in the use of natural building materials
SWECO Umeå	Sweden	Sustainable materials sourced from the region	Selected as an example of a larger company using materials certified to the highest standards

In Greenland, the submissions reflected challenges in obtaining submissions from this region resulting in an inability to identify a successful Best Practice. This reflects the reliance on imported building materials from Denmark and limited economies of scale for local products and services. A lack of local training and investment problems associated with investment levels required for research and development of materials suitable for the Arctic climate were observed. Economies of scale were identified to be a common barrier limiting the potential for growth in all regions. Low population density in Greenland and Sweden restricts the market potential for such products and services at a commercial level locally. Sweden relies on large organisations to invest in the region in order to promote these products to the mass market. In Scotland and Ireland, the focus is on mirco-enterprises and two types of organization were observed with 1) lacking the desire to grow due to the local scale of the business satisfying the needs of the shareholders, and 2) those that have the desire to grow but lack the skills and experience to grow their business.

The process also enabled the identification of some common barriers to mainstreaming sustainable building materials. Simple lack of awareness of their benefits (and co-benefits) amongst the construction industry, housing developers, and the public was a commonly-cited barrier, along with a lack of professional training opportunities for architects and house builders. However, where clients were aware, or made aware, they were reported to have found them preferable for reasons such as being safer for installers and more aesthetically pleasing for occupants. A potentially more significant barrier, and a key finding of the study, was the costs of achieving relevant certification for products manufactured by the smaller companies, and the potential consequences of making claims without that certification. Larger competitors using conventional products and materials were commonly viewed as being litigious towards smaller companies who promote the sustainability of their products and services, and even the risk of legal action was seen as sufficient to deter them from making such claims. This was further compounded by the financial and staff resource costs of achieving relevant certification, and the project produced an example of this.

Of the smallest Best Practices, Ecocel was notable in having an important benefit (improved thermal regulation over conventional insulation) certified by testing carried out at Delft University, the Netherlands (Ecocel, 2013). Therefore, in order to meet the aim of the NEES project to support the development of small businesses and better understand barriers to growth, the project funded another of the smaller Best Practices, Enviroglass, to be assessed for the Carbon Trust's Product Footprint label, which is the UK's most established certification scheme for low carbon products (Carbon Trust, 2017). Enviroglass, which recycles ~99% of Shetland's waste glass into paving and aggregate products, and which was fending off an attempt by the Scottish Government to require this to be exported to a recycling facility on the Scottish mainland, was seen as an excellent example of a small business which should benefit from certification.

However, although certification was achieved, this proved to be an arduous process which ran significantly over-time and over-budget (the final cost being approximately £13,000 from an estimated budget of approximately £6,000, excluding staff time for Enviroglass). For this, the GCU team contracted a qualified Carbon Trust assessor, paid for the necessary software licence, and managed the contracts and relationships between the three parties. Of the many problems that befell the project the usability of the software, even for an experienced assessor, and difficulties in accessing an electricity meter caused

the most significant delays and added costs. The latter was due to Enviroglass's meter being sited in locked premises next door which were rarely used by the tenant, and who proved difficult to contact, and provides a useful example of a practical problem encountered by the smallest businesses working under ad-hoc arrangements (Enviroglass employs two staff who work across the Shetland Isles), and who were typical of the applicants from Scotland and Ireland. For such a small community-based business the staff time required to achieve certification was significant, and as such the main consequence of this experience, rather than to develop a case study to encourage other small businesses to invest in certification, turned out to be exactly the opposite.

A related set of issues was raised by the experience of another Scottish Best Practice, Inzievar Woodlands. Inzievar consists of a sawmill, which processes almost all of the native hardwood and softwood timber grown in Scotland, and a woodland managed for co-benefits including biodiversity, recreation and tourism. As part of engaging the Best Practices with the project, NEES team members visited each of the businesses to interview them about issues including barriers to growing their businesses, and the interview with the staff at Inzievar produced an important observation which was also reflected by other smaller Best Practices – *"we don't want to grow, we just want neighbours"*. This comment reflects a wider critique which emerged from many of the interviews but particularly the smaller companies, that of questioning both the 'growth is good' assumption that is inherent in many political conceptualisations of sustainable development, and within this the role of 'innovation for the sake of innovation' as a driver for growth.

A more nuanced view on growth, articulated particularly by the architects, was about the quality of the jobs created by growth and the benefits of training and retaining skilled employees in rural areas. Measures to promote innovation through competitive funding were also frequently cited as a barrier to growth, in that in order companies were having to add 'something innovative' to their products and services in order to be eligible to apply for support. In some cases this had been overcome by partnering with universities, but was generally seen as an added expense that some felt would be better spent on funding retrofits using existing, proven, energy efficient products and materials.

Conclusions

The title of this paper comes from a quote by Ralph Waldo Emerson, chosen because it articulates the responses of clients of the NEES Best Practices, and of the many policy makers and members of the public who engaged with many activities carried out as part of the project. At no stage did any of the project team encounter any resistance or objections to the benefits (and co-benefits) of promoting locally-sourced, natural and sustainable building products and materials, and these have now been recognised in Scottish policy (Pridmore et al., 2017; Scottish Government, 2017).

Yet in Scotland, and to differing degrees across the European Union, much more needs to be done if we are to re-mainstream the use of sustainable building materials and avoid losing the traditional skills, and skilled tradespeople, needed to sustain these industries. As the Best Practices illustrate, these industries are highly diverse both in terms of the products and services they offer, and of the nature of the companies themselves. This means that whilst some will be receptive to conventional market-led policy responses, the

needs of others may be better met through more holistic approaches to promoting energy efficiency and social and economic regeneration in rural and island areas.

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